Filing Receipt

Received - 2021-09-30 01:57:13 PM
Control Number - 52373
ItemNumber - 149

PUC PROJECT NO. 52373

REVIEW OF WHOLESALE ELECTRIC MARKET DESIGN	§ §	**PUBLIC UTILITY COMMISSION OF TEXAS**

COMMENTS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

The Texas Section of the American Society of Civil Engineers (ASCE), while not a usual commenter at the Public Utility Commission of Texas (PUCT) is the leading technical resource on Texas' Infrastructure. Critical infrastructure, including water, power, transportation, natural gas, and telecommunications is something most people take for granted. With the flip of the switch, there is light or with the turn of the faucet, clean water runs. Lives and livelihoods depend on the reliability and resilience of critical infrastructure.

ASCE represents more than 150,000 members of the civil engineering profession in 177 countries. Founded in 1852, ASCE is the nation's oldest engineering society. ASCE released its most current national Infrastructure Report Card (IRC) in February 2021. The Texas Section of ASCE represents nearly 10,000 members throughout the State and released its state-level IRC in February 2021. Both IRCs follow a standard report card assessment. The assessment is performed periodically on various critical infrastructure sectors (e.g., water, energy, roads, etc.) and provides a view of the condition and performance capacity of the various sectors of infrastructure. It is undertaken to educate the public and those in government who oversee such matters. In addition, when a catastrophic event takes place and infrastructure fails, ASCE deploys skilled engineers from its membership to assess and determine what happened, why it happened, and more importantly, to develop recommendations for future change, as appropriate, to avert such an event. ASCE convened a task committee as Texans experienced Winter Storm Uri.

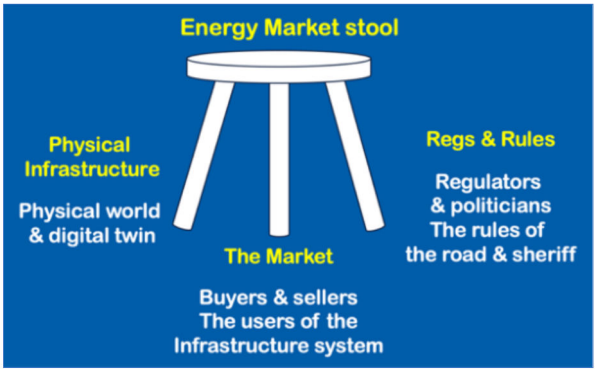
ASCE's preliminary findings and recommendations on the reliability and resilience failures exposed by Winter Storm Uri include:

1. Invest in black start generation to ensure reliable and resilient fail-safe back-up power.
2. Restructure regulatory flaws negatively impacting dispatchable generation reliability.
3. Mitigate growing interdependency between infrastructure sectors.
4. Prioritize reliability and resiliency focused regulations and eliminate regulations that include the unintended consequences of creating negative reliability or resiliency impacts.
5. Replace process and model biases and the reliability-sacrificing pursuit of short-term price reductions with a reliability and resilience prioritized culture.

FORMATION OF THE ASCE BEYOND STORMS INFRASTRUCTURE NETWORK RESILIENCE TASK COMMITTEE

During the peak of Winter Storm Uri in February 2021, ASCE members recognized that the IRC that had been recently prepared for the energy sector of Texas focused on the physical infrastructure of each sector; not the regulatory and energy markets impacting the infrastructure or the interconnection issues between sectors. Even before power was fully restored, teams of ASCE experts were tasked to understand what happened and why it happened. The ASCE Texas Section Beyond Storms Infrastructure Network Resilience Task Committee was formed. The Task Committee discovered the majority of the infrastructure itself performed as anticipated given the circumstances. The team discovered more consequential failures in the manner the infrastructure was being used and the increasing risk of interdependence between sectors that had reached a tipping point. Interdependence occurs when the performance of the infrastructure of one sector is mutually reliant on the performance of another sector. Major reliability failures were exposed by Winter Storm Uri, but these failures extend well beyond the February 2021 storm.

ASCE determined that it needed to consider issues beyond the storm itself and beyond the traditional ASCE sector by sector strategy. It was necessary to look beyond the physical infrastructure to understand the root causes of the most significant problems Winter Storm Uri revealed. Three legs of the Energy Market Stool were considered, including physical infrastructure, the impact of regulations that apply to the use of the infrastructure, and the markets themselves (see below figure).



The energy infrastructure system works or fails by the way these three legs of the energy industry effectively work together. Our analysis of Winter Storm Uri led us first to the energy rules and market structure that undermine the reliability and resilience of the critical infrastructure. The next most impactful contributor to reliability degradation was determined to be interdependence, where one sector becomes increasingly reliant or interdependent on another sector(s). The relentless creep of interdependence between infrastructure sectors, contributes to increasing the fragility of each system(s) and sets the stage for cascading failures across sectors.

ASCE'S PRELIMINARY FINDINGS AND RECOMMENDATIONS ON RELIABILITY AND RESILIENCE FAILURES EXPOSED BY WINTER STORM URI

ASCE recognizes that much work has already started to mitigate these findings, at the PUCT, at the Electric Reliability Council of Texas (ERCOT), and at the stakeholder level. This report highlights the infrastructure related issues and does not acknowledge the work that is currently underway at the many different levels. Ultimately, ASCE will issue a comprehensive report comprised of a review of both sector specific issues and the interdependence network level issues connecting the infrastructure sectors. The focus of this Task Committee's effort has been on reliability and resilience with a prioritized emphasis on the most impactful areas for improvement. The timetable for the full report has been targeted for the first quarter of 2022 and remains on track. Because the PUCT requested comments related to market design, ASCE is providing preliminary overall findings herein. As independent stewards for critical infrastructure, ASCE believes it is imperative these conclusions and recommendations are considered by the PUCT in the pending discussions.

Winter Storm Uri's economic impact is estimated to exceed[1] the equivalent impact from either Hurricane Harvey or Katrina. The weather itself had an independent impact on a portion of these costs. However, ASCE found that the failure of the electricity grid was directly and indirectly a material contributor to economic harm and human tragedy experienced from Winter Storm Uri. Texas has a substantial and growing electric system reliability and resilience problem that extends beyond Winter Storm Uri. Ensuring Texas has a reliable electric system in an increasingly electrified economy is critical to the safety, economic health, and future of our fellow Texans. ASCE concludes that severe negative impacts ***will*** increase in frequency and duration due to market design shortcomings, growing infrastructure interdependence, economic and population growth drivers, and aging equipment ***even if*** the frequency and severity of weather events remains unchanged.

There is a legacy of chronic under-investment to maintain critical infrastructure across the United States. Many of these impacts are the most acute for those members of society at the margin who rely on critical infrastructure and with few viable options. This pattern of underfunding, deferral, and avoidance, results in a costly "run to failure" outcome that negatively impacts reliability and resilience and must change. Some leading cities, like the City of Houston, are implementing a pay as you go policy that includes reducing debt and keeping current on maintenance and upgrades to their critical infrastructure. They know that "run to failure" is not a proactive, effective strategy. Critical infrastructure impacts all of society and it needs consistent investment to remain reliable and resilient.

Texas has long been a leader in energy and innovation. The Texas electric grid has been in a constant state of evolution to accommodate new technologies, grid expansions and satisfy growing demand

since its formation. During the current transition, substantial federal and state incentives supporting new intermittent wind and solar resources have led to the dramatic growth of renewable energy resources in Texas. Recent and growing additions of utility scale energy storage confirm another stage of transition. ASCE recognizes that the grid will continue to evolve and that the grid of the future will not look like today's grid. During this evolution the need for reliability and resilience cannot be sacrificed as they will steadily grow in importance due to increased electrification and the risks from interdependence.

The energy industry is one of the most capital-intensive industries in the world. Like most critical infrastructure, it requires large capital expenditures to support expansion, maintenance, and operations. Policies, regulations, and markets that distort, constrain, or negatively impact the flow of capital to needed investment starves reliability through deferred expansions, delayed maintenance, and reduced reliability investment. The reliability of critical infrastructure, from transportation and energy to water, wastewater, and telecommunications, is heavily impacted positively or negatively by ongoing investments supporting maintenance and reliability upgrades.

ASCE identified two primary related problems that were the most significant contributors to reliability degradation:

(1) A failure to support reliable electric power generation, and

(2) The negative impact on revenue sufficiency due to intermittent sources of electric power generation.

This assessment concludes that revenue insufficiency from the energy-only market model fails to adequately compensate reliable dispatchable generation or provide the necessary revenue to maintain the electric power generation infrastructure and that these deficiencies are a leading contributor to the ERCOT system being less reliable. The next most consequential degradation factor identified is the rapidly growing interdependence between critical infrastructure sectors. Like energy transition, interdependence is increasing, and it cannot continue to be ignored. The effects of interdependence will continue to deteriorate reliability without action. Interdependence can be mitigated, fragility improved, and reliability enhanced by implementing a series of actions that are relatively modest in scale, focus on enhancing the reliability of the ERCOT region, and mitigate the interdependence risk between critical infrastructure sectors. The final two material reliability degradation factors work in more subtle ways. These two contributors include rules, policies and regulations that create negative impacts to reliability instead of enhancing them, and a legacy ERCOT market philosophy that has sacrificed reliability priorities in the pursuit of low cost.

ASCE offers the following preliminary findings and detailed recommendations regarding the energy infrastructure within Texas:

1. **Invest in black start generation to ensure reliable and fail-safe back-up power.**

   The loss of the entire grid would be catastrophic. During Winter Storm Uri, ERCOT narrowly averted such an event. The entire state could have suffered without power for weeks or possibly longer. Pat Wood, III, the former chairman of the PUCT and the Federal Energy Regulatory Commission (FERC), described these conditions as being "equivalent to going back to the stone age".[2]

   ERCOT has 13 primary black start generators (the primary fail-safe to the system) and 15 secondary generators (the equivalent of back-up generators to the back-up generators) for a grand total of 28 generating black start units[3]. An unprecedented 75% of the 28 most critical, reliability fail-safe back-up generators did not reliably perform when called upon during the Energy Emergency Alert (EEA). Texas was less than 4 ½ minutes from black start conditions on Monday morning February 15, 2021.

   Detailed Recommendations: Texas must provide a consistent, reliable, and adequate funding mechanism to satisfy revenue sufficiency for the black start generators to support the following reliability investments:

   a. Ensure revenue sufficiency to support reliability and resilience investments including winterization, availability upgrades, and operations consistent with top decile performance.
   b. Require dual fuel capability for non-hydroelectric facilities with a minimum dedicated on-site fuel storage of 14 days running at 24/7 with regular best in class confirmation testing of this capability.
   c. Replace Black start generation that is incapable of dual fuel service or unable to meet minimum top decile reliability and resilience metrics.

2. **Restructure regulatory flaws negatively impacting dispatchable generation reliability**.

   The ERCOT energy-only market prioritized cost above reliability. It created a predictable and known underinvestment in infrastructure from deteriorating economics that is directly responsible for the ongoing erosion of reliability from dispatchable generation[4]. The design and supporting rules rely on the unfounded "hope" that potential periodic scarcity premiums will be sufficient to incentivize reliability investments, including winterization and greenfield construction of dispatchable generation. Generators were not required to invest in winterization. It was left to generators to make rational decisions[5]. The economic reality is that if dispatchable generation that has been unable to earn its cost of capital in nine of the last 10 years[6] the same generator is also unlikely to invest in winterization, firm fuel supply, dual fuel flexibility, or other reliability related investments. ASCE recommends a market mechanism that rewards reliability, whether the unit is dispatched or not, balanced with reasonable electricity prices for consumers to replace the current flawed energy-only market with subsidized intermittent generators that solely depends on scarcity pricing to provide revenue sufficiency for

reliability investments. This can be done with a hybrid approach that enhances the existing energy-only market.

Detailed Recommendations: ASCE provides a hybrid solution to enhance the current energy-only model with a reliability focused solution that addresses the failures of the legacy energy-only market. ASCE recommends the creation of a Reliability Focused Power Market (RFPM) with the following attributes.

a. The RFPM would provide revenue sufficiency for reliability and dispatchability that include winterization, firm fuel supply, market area storage, reliability investments, dual fuel capability (as needed) and supporting infrastructure (upstream). These investments in generation would help underwrite investments in adjacent sectors
b. Simple-cycle Gas Turbines should be supported through revenue sufficiency from the RFPM to convert to dual fuel capability with liquid storage capacity for secure winter peak availability and create further system benefits from fuel diversity impacts on marginal energy price and as potential supplemental resources to prevent a black start condition.
c. As an integral part of RFPM, the PUCT, consistent with TX SB3, must establish industry-leading operational and reliability metrics applicable to the generator, including weatherization, with financial consequences applied for failure to generate reliably during extreme weather events.
d. All generators must meet their bid commitment. An effective RFPM would implement new incentive and penalty solutions applied to all generators that miss their bid commitment or forecast (high or low) within certain transparent bands of tolerance with the penalties (for performance outside of the tolerance bands that should be borne by the generator that failed to perform in an approach consistent with cost causation, adjusted for reflective top quartile Forced Outage Rates.

3. Mitigate growing interdependency between infrastructure sectors.

Explicit interdependence, where major reliance by one sector, is well known. Interdependence Creep is where individual decisions about interdependence between sectors might not rise to a level of concern but when this one-off integration is repeated hundreds or thousands of times the result creates a systemic risk issue. The expanded reliance on electricity driven solutions by the natural gas industry for production, controls, operations, and storage is increasing the fragility of both sectors. Public policies, regulations and business decisions that increase interdependency must include the quantification of reliability considerations. These issues were material contributing factors in cascading sector failures.

Detailed Recommendations: Interdependence will continue to grow. However, the risk associated with this growing interdependence can be mitigated. The natural gas industry must harden critical natural gas infrastructure to help ensure reliable natural gas service that the electric industry, liquefied

natural gas (LNG), and other consumers rely upon. An unreliable gas supply and transportation system serves no one. The Texas Railroad Commission (RRC) should take steps to:

a. Stop incremental issues by implementing standards for all new upstream and midstream infrastructure, to ensure minimum reliability and resilience in severe weather events.
b. Address the legacy issues by working with producers and midstream participation to develop standards and a schedule of prioritized investment(s) to upgrade and assist in funding if needed, existing production and midstream infrastructure modification for severe weather.
c. Address full field electrification that creates substantial increases in interdependence. Proactively mitigate growing interdependence through support of cyber secure microgrids and back-up power solutions at identified critical natural gas infrastructure locations.
d. Ensure that the energy-only market does not negatively impact the higher reliability capacity market model of the natural gas industry at either the intrastate or interstate level. Generators must pay for the quality of service that it requires and not rely on subsidization.
e. Coordinate with the LNG Industry. Work with industry, ERCOT and the PUCT to develop contractual arrangements with the LNG industry that establish appropriate compensation of LNG plants to provide flexibility to temporarily redirect their natural gas for short term peak system needs during EEAs.
f. Work with PUCT to discourage reliance on paper-based reliability solutions. Restructure the Critical Load filing process to establish a relative priority order for each load and a requirement to ensure that the distribution entity has completed distribution control investments to properly support the CLF prior to acceptance of filing. The timetable should be such that these firm loads are not approved until they can be incorporated into ERCOT seasonal planning efforts. Specific critical loads should be identified for alternative reliability investments, such as microgrids and back-up generation that deliver reliability to the end user and the grid. The Critical Load filings can effectively decrease system reliability by increasing prioritized firm power demands and reinforce the misperception that CLF increase actual reliability levels.

4. Prioritize reliability focused regulations and eliminate regulations that include the unintended consequences of creating negative reliability impacts.

Prioritize reliability focused regulations and incentives. Eliminate regulations and subsidies that include the unintended consequences of creating negative impacts to reliability. Support policies that enhance or contribute to reliability. Government and industry can benefit from understanding how H-E-B, LP built a culture that proactively took steps in superior preparedness in advance of the pandemic to prepare, manage and resource for the crisis. The H-E-B, LP culture of proactively managing reliability and resilience should be embraced by ERCOT.

Detailed Recommendations: ERCOT should take steps to:

a. Work with the PUCT to preclude interruptible and island end user demand (end user, microgrid, etc.) from returning to the system and adding incremental demand on the system during peak periods and system emergencies unless authorized by ERCOT.
b. Implement System policies that prevent utility scale batteries from re-charging (consuming power) while ERCOT is on the verge of failure from frequency deterioration. Prohibit battery solutions to be net consumers of power during system emergencies unless required by ERCOT.
c. Work to increase support for dispatchable renewable resources including biomass, waste to energy, geothermal, hydroelectric, and long-duration storage (>24-hour duration).
d. Ensure a sufficient number of credit providers are accessible on an over the counter (OTC) basis and available 24 hours a day, 7 days a week during severe weather events to support the needs of market participants.

5. **Replace process and model biases and the reliability-sacrificing pursuit of short-term price reductions with a reliability and resilience prioritized culture.**

The over-reliance and failure of a model driven culture was on display prior to, during and after Winter Storm Uri. Forecasts, models, and expectations were materially inconsistent with reality. The subsequent response to the storm doubled down on this strategy with a fix the model solution bias to avoid fundamental re-thinking. This problem is compounded by a lack of clear ownership and accountability for performance[7] that is a common element throughout ERCOT self-reflection[8] about the events and a focus on their cost vs. reliability of the system. There were significant failures in managing Critical or Critical Load requests, from paperwork failures to lack of system control upgrades to manage these loads. The market relied on the failed assumption that critical load filings would satisfy their individual reliability requirements without understanding the reality of this paperwork-based process. The addition of incremental critical loads to the system increases the implied level of firm load on the system, reducing flexibility and hurting reliability. Reliability and resilience are not performance outcomes that can be inspected or audited into the system. Reliability must be integrated into daily operations like how a business successfully approaches safety.

Detailed Recommendations :

a. Restructure Critical Load filing processes consistent with 3.f. above.
b. Conduct disaster simulation exercises that include all impacted infrastructure entities and governmental agencies to regularly test and sharpen skills in response to system emergencies and identify process and risk areas. Seasonally focused scenario development and training should be scheduled and completed prior to the beginning of the season. Training is never ending. A system disaster simulator that includes interdependent sectors, like what has proven effective in training

pilots and nuclear plant operators should be developed for ERCOT for training and experience between sectors by sector teams.

c. ERCOT should be periodically reviewed by an independent agency and benchmarked against leading Independent System Operators.

d. ERCOT must be held fully responsible for changing its processes, decision making and culture to a reliability centric ecosystem. This responsibility should not be diluted or delegated. The PUCT should be the entity responsible for holding ERCOT accountable for changes, metrics, and Key Performance Indicators.

CONCLUSION

The Texas Section of the American Society of Civil Engineers (ASCE) appreciates the opportunity to provide these recommendations and looks forward to working with all interested parties to solve critical infrastructure issues. Furthermore, ASCE trusts the recommendations presented herein constructively inform the PUCT of the critical infrastructure issues that must be addressed and measures to be taken to prevent another similar disaster, in any season. Most importantly, the possibility of grid collapse and subsequent black start that would result in cataclysmic loss of life, property, and societal injury can feasibly be eliminated with improvements to infrastructure assets, market management, interconnected system coordination, and improved functional management across the entire system.

Respectfully submitted,

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End Notes

[1] The Perryman Group – Preliminary Estimate of Economic Costs of the February 2021 Texas Winter Storm, February 2021 (low case = $197.2B, High case= $295.8B)

[2] KUT Radio, Austin's NPR station, August 5, 2021 If the Texas Power Grid Had Gone down, it would need a black start! How Long would that take?", by Mose Buchele, Matt Largey.

[3] According to the Black Start Working Group Presentation to the Reliability and Operations Subcommittee on June 3, 2021 9 of the 13 primary black start generators experienced an outage during Uri or had forced outage or fuel problems and tripped offline and 12 of the 15 secondary generators had forced outage events during the EEA. This means that a total 21 of 28 (75%) black start generators had operational issues during the winter event. 18 of these 28 units have only a single fuel resource, 7 of 32 outage causes were related to lack of fuel (the report does not provide the reason of the shortfall - supply, transport or contractual).

[4] NREL Revenue Sufficiency and Reliability in a Zero Marginal Cost future, 2016

[5] According to Wood Mackenzie[5], "…During the 10 years prior to 2021, ERCOT's Energy-only market did not provide a meaningful signal for natural gas or wind generators to winterize."

[6] Wood Mackenzie, March 4, 2021 report on Texas Grid Failure and Implications for the Energy Transition.

[7] Pages 17, 21: Review of February 2021 Extreme Cold Weather event – ERCOT presentation, February 25,2021

[8] ERCOT Texas legislative Hearings 2-25-2021, Review of February 2921 Extreme Cold Weather Event – ERCOT Presentation by Bill Magness